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**INTEGRATED TOUCH SCREEN AND OLED FLAT-PANEL  
DISPLAY**

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## **INTEGRATED TOUCH SCREEN AND OLED FLAT-PANEL DISPLAY**

### **FIELD OF THE INVENTION**

The present invention relates to touch screens for use with organic  
5 light emitting diode displays and, more particularly, to an integrated touch screen  
and OLED flat-panel display.

### **BACKGROUND OF THE INVENTION**

Emissive flat-panel display devices are widely used in conjunction  
10 with computing devices and in particular with portable devices. These displays  
are often used in portable devices or in public areas where the use of a keyboard in  
association with the computer used to drive the display is impractical. In these  
situations, a touch screen interface to the display is often employed.

A touch screen is a device placed over or above a display which  
15 provides a signal when the screen is mechanically touched. There are a variety of  
detection methods used including capacitive, surface acoustic wave, infrared, and  
resistive (with either four or five wires). With the exception of the infrared  
method, each of these methods relies on a hard substrate into or onto which  
various signals and detecting devices are built. Resistive touch screens have a  
20 conductive coating deposited upon the substrate and a conductive, flexible cover  
sheet placed over the substrate that is indented by a stylus or finger to create an  
electrical connection between the conductive flexible cover and the conductive  
substrate. The flexible cover sheet extends over the substrate except for a portion  
where electrical connections are made to the substrate. Electrical connections to  
25 touch screens are typically made by soldering a cable having a plurality of wires  
to the conductive face of the substrate in this exposed area. US Patent 4,893,115  
titled "Touch Sensitive Visual Display System" issued January 9, 1990, describes  
a resistive wire touch screen known in the art

Flat-panel display devices such as OLEDs and LCDs utilize a  
30 similar approach in providing electrical connections to the display. These display  
devices have conductors and electrical components integrated onto a substrate and  
electrically connected via a cable at an exposed location on the substrate.

It is known to use the substrate of a resistive touch screen as the substrate of an LCD display. US Patent 6,483,498 titled “Liquid Crystal Display With Integrated Resistive Touch Sensor” granted to Colgan et al and issued November 19, 2002 describes a liquid crystal display that includes a first substrate

5 having a first conductive layer formed thereon. A linearization pattern is formed on the first conductive layer for applying voltage gradients across the first conductive layer. A flexible polarizer is included having a second conductive layer formed thereon facing the first conductive layer across a gap formed there-between, the polarizer providing a contact surface such that a touched position on

10 the polarizer causes contact between the first conductive layer and the second conductive layer thereby identifying a location of the touched position. However, this arrangement requires cable connections on two substrates and in different areas, thereby increasing the difficulty and decreasing the robustness of cable connections.

15 US Published Patent Application No. 2002/0186208 titled “Organic Electroluminescent Display With Integrated Touch Screen” published December 12, 2002 discloses an electroluminescent display with integrated touch screen, including: a transparent substrate having two faces; a flat panel display matrix forming an electroluminescent display located on one face of the substrate

20 for emitting light through the substrate; touch sensitive elements of a touch screen located on the other face of the substrate; and a single flex-cable containing a plurality of conductors electrically connected to both the flat panel display matrix and the touch sensitive elements for providing external electrical connection to the display. However, this arrangement also requires cable connections on two

25 substrates and in different areas, thereby increasing the difficulty and decreasing the robustness of cable connections.

As noted, these arrangements do not optimize the space needed to provide connections to both the touch screen and the flat-panel display. It is also important to minimize the size of peripheral borders for both touch and display screens. Moreover, signals for both the display and touch screens must be processed before use and the configurations in the prior art do not provide the capability for integrating the cabling and associated processing.

There is a need therefore for an improved integrated touch screen and OLED flat panel display.

### **SUMMARY OF THE INVENTION**

5           The need is met according to the present invention by providing an integrated touch screen and OLED flat-panel display that includes a) a touch screen having a touch screen substrate with electrical contacts for receiving touch screen signals and conductive vias through the substrate and electrically connected to the electrical contacts; and b) an OLED flat-panel display having a display 10 cover and a display substrate with electrical contacts for receiving display signals and an exposed area on the display substrate for providing electrical connection to the electrical contacts of the display and the touch screen; wherein the touch screen substrate forms the cover or substrate of the OLED flat-panel display, the conductive vias are electrically connected to conductors and electrical contacts 15 located on the display substrate, and the substrate of the OLED flat-panel display protrudes beyond the display cover to provide electrical connection to the electrical contacts of the display and touch screen.

### **ADVANTAGES**

20           The present invention has the advantage that it reduces the costs and improves the reliability and performance of a touch screen that is used with an OLED flat-panel display by integrating cable connections on a single substrate and providing touch screen signal processing on the display substrate.

### **25           BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a schematic side view of one embodiment of the integrated flat-panel display and touch screen of the present invention;

Fig. 2 is a schematic top view of the embodiment shown in Fig. 1;

Fig. 3 is a schematic top view of an alternative arrangement of 30 electrical connections according to the present invention;

Fig. 4 is a schematic top view of an alternative arrangement of electrical connections according to the present invention; and

Fig. 5 is a schematic side view of an alternative embodiment of the integrated flat-panel display and touch screen of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

5 According to the present invention, an integrated resistive touch screen and flat-panel top-emitting OLED display **8** overcomes the problem of multiple external electrical connections by employing a flat-panel display having a substrate that extends beyond the substrate of the resistive touch screen. Referring to Fig. 1, a display substrate **10** is affixed using an adhesive **14** to a cover **12** that is also the substrate of a resistive touch screen. Any space between the substrate **10** and cover **12** may be left empty or filled with any one or more of a variety of materials to improve the sealing and robustness of the display, for example, desiccants, liquids such as oils, polymers, pressure sensitive adhesives, and adhesives such as epoxies. The substrate **10** protrudes beyond the cover **12** to expose electrical connections **26** formed on the substrate **10** and to which are connected a cable **20**. The electrical connections **26** electrically connect display elements of the display **8** to the cable **20**. The resistive touch screen includes a flexible top sheet **30** and spacer dots **32** separating the cover **12** and the flexible top sheet **30**. Other touch screens having a substrate may also be used, for example resistive, capacitive, inductive, optical or surface acoustic touch screens. These touch screens are well known in the art.

10 Electrical connections **27** are also formed on the cover **12** and can be located either underneath (as shown) or outside the flexible top sheet **30**. Placing the connections **27** under the flexible top sheet **30** may save space on the periphery of the touch screen, thereby increasing the relative active area of the touch screen. This is an important issue, since, in general, the inactive periphery of a touch screen is greater than that of a flat-panel display. Electrically conductive vias **28** connect the touch screen connections **27** through the cover **12** to the substrate **10** of the display **8** and connect to the electrical connections **26**.  
15 Thus, the touch screen electrical connections **27** are provided on the substrate **10** and may be connected at a single location to the single cable **20**.

In an alternative embodiment, the touch screen is not the cover but the substrate of the integrated resistive touch screen and flat-panel top-emitting OLED display 8. Referring to Fig. 5, the substrate 10 of the display is also the substrate of the touch screen. The electrical connections 26 and 27, vias 28, and 5 cable 20 are all connected as described above.

The substrate 10 or cover 12 are typically coated with ITO or another suitable conductor for providing conductivity for the touch screen or display. After the initial coating is applied and any desired additional processing, holes are formed by drilling or etching into the substrate 10 or cover 12. The 10 holes are then coated or filled with conductive material, such as a metal or metal composite like solder, to form conductive vias 28. In the case where the vias 28 are formed in the cover 12, an additional ball of conductive material having a low-temperature melting point, such as solder, is located on the via 28 so as to contact the substrate 10. After the substrate 10 and cover 12 are placed in contact and 15 adhered (usually around the perimeter), the assembly may be heated to melt the solder and form an electrical connection between the via 28 and connections 26. Since the distance between the cover 12 and the substrate 10 is typically very small, for example 10-50 microns, an electrical contact may be established and maintained. Alternatively, the contact material may not be heated and may simply 20 form a mechanical contact in slight compression.

Referring to Fig. 2, a top view of the arrangement of Fig. 1 is shown. In Fig. 2, a plurality of touch screen electrical connections 27 on the cover 12 are shown. The touch screen electrical connections 27 are electrically connected through vias 28 to the plurality of electrical connections 26 connected 25 to an electrical cable 20 on the substrate 10. The electrical connections 26 include connections 23 for light emitting components on the substrate 10 and the connections 24 for the touch screen. A wide variety of physical arrangements are possible. The connections 23 and 24 may be interdigitated within the cable 20, for example. The electrical connections 27 on the cover may be made through the 30 vias 28 located in a wide variety of positions on the cover 12. As shown in Fig. 3, the vias 28 are placed near the corners of the active areas of the touch screen. Moreover, the cable 20 may comprise one or more separate cables.

Signals from electrical connections 27 of the touch screen through the vias 28 may be processed on the substrate 10. In typical flat-panel, active-matrix displays, processing circuitry is provided to drive the individual light emitting elements of the display. Circuitry using similar components, for example 5 resistors, transistors, and capacitors may be used to build up complex signal processing circuits that may be employed to process the touch screen signals. The circuits may be electrically connected to the touch screen electrical connections 27 and produce output signals provided on the electrical connections 26 and then connected to the cable elements 24 and the cable 20. Referring to Fig. 4, a circuit 10 29 is electrically connected to the touch screen electrical connections 27 through vias 28 and produce output signals electrically connected to the cable elements 24 and the cable 20.

The present invention can be employed in most top- or bottom-emitting OLED device configurations. These include simple structures 15 comprising a separate anode and cathode per OLED and more complex structures, such as passive matrix displays having orthogonal arrays of anodes and cathodes to form pixels, and active matrix displays where each pixel is controlled independently, for example, with a thin film transistor (TFT). As is well known in the art, OLED devices and light emitting layers include multiple organic layers, 20 including hole and electron transporting and injecting layers, and emissive layers. Such configurations are included within this invention.

In a preferred embodiment, the invention is employed in a device that includes Organic Light Emitting Diodes (OLEDs) which are composed of small molecule or polymeric OLEDs as disclosed in but not limited to US Patent 25 4,769,292, issued September 6, 1988 to Tang et al. and US Patent 5,061,569, issued October 29, 1991 to VanSlyke et al. Many combinations and variations of organic light emitting displays can be used to fabricate such a device.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations 30 and modifications can be effected within the spirit and scope of the invention.

**PARTS LIST**

- 8 integrated OLED display and touch screen
- 10 substrate
- 12 cover
- 14 adhesive
- 20 electrical cable
- 23 electrical cable
- 24 electrical cable
- 26 electrical connector
- 27 electrical connector
- 28 conductive via
- 29 circuits
- 30 flexible top protective layer
- 32 spacer dot